Replacement Specification – Clean Copy
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CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/549,184, filed March 2, 2004, whose entire contents are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

It is known to provide molded plastic taps for use with containers, in particular disposable containers of the type popular for supplying liquid such as water, wine or milk. One well known type of tap for this purpose is a so-called push button tap having a resilient plastic diaphragm which, when pressed, opens the valve to allow liquid to flow from the container. The resilient plastic diaphragm, commonly referred to as a "push button," can be arranged so that it positively urges the valve into a sealing position when manual pressure is removed therefrom. The tap is therefore self-closing.

An alternative to push button taps are the so-called "rotary" taps. In these, a cap is rotated to in turn rotate a stem within the tap body. Rotation of the stem causes it to uncover an aperture provided in the tap body through which or from which liquid is dispensed.

Irrespective of the type of tap used with a container, it has been found that smooth liquid flow with a stabilized flow profile can only be achieved if either the container is flexible, collapsing as liquid is dispensed, or the container is vented. The reason for this is that otherwise air must flow into the container to fill the space from which liquid has been vacated and equalize the pressure within the container. The inflow of air disrupts the outflow of liquid causing it to be uneven and reducing the flow rate.

SUMMARY OF THE INVENTION

Disclosed herein are air-vented closures for a fluid container, each closure having a dedicated liquid conduit and a dedicated air conduit. This allows air to flow into the container without encountering static or flowing liquid in the air conduit.

In an embodiment, an air-vented closure has a body having a docking member for connecting the closure to a container. The body has a first conduit and a second conduit, the first conduit being adapted for conveying liquid and having a liquid outlet, the second conduit being adapted for conveying air and having an air inlet. The closure also has a member having opposed first and second ends with a liquid outlet at the first end and an air inlet at the second end. The member is positionable with respect to the body from a closed position where no liquid flows through the first conduit to an open position where liquid can flow through the first conduit.

In another embodiment, the closure assembly has a valve body and a valve element. The valve body has a first fluid conduit and a second fluid conduit spaced from the first conduit. The valve body has a mounting sleeve in fluid communication with the first fluid conduit and the second fluid conduit, the mounting sleeve has an axis therethrough. The valve member may be positioned in the mounting sleeve for reciprocating movement therein from a closed position to an open position in response to rotation of the valve member about the axis. The valve member has a wall having a first end and an opposed second end, the valve member having a third fluid conduit therethrough. A first portion of the wall of the valve member may be removed to define an air inlet into the third fluid conduit and a second portion may be removed to define an air outlet from the third conduit. When the valve member is in the closed position a

portion of the valve member blocks fluid flow through the first conduit and a portion of the mounting sleeve blocks air flow from the air outlet. When the valve member is in the open position, fluid can flow through the first conduit and air can flow through the air outlet.

Also disclosed herein is a fluid container having an air vented closure attached thereto.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is an isometric view of a closure assembly of the present invention;

FIG. 2 is an end view of the closure of FIG. **1;**

FIG. 3 is a side view in partial cross-section of the closure of **FIG. 1;**

FIG. 4 is a plan view in cross-section of the closure assembly taken along line X-X of FIG. 3;

FIG. 5 is a fluid container with the closure assembly of FIG. 1;

FIG. 6 is a side view in partial cross-section of the closure assembly in a closed position;

FIG. 7 is a side view in partial cross-section of the closure assembly in an open position;

FIG. 8 is a schematic view of an embodiment of an air vent of a valve element in an open position;

FIG. 9 is a schematic view of an embodiment of an air vent of a valve element in an open position;

FIG. 10 is a schematic view of an embodiment of an air vent of a valve element in an open position;

FIG. 11 is a schematic view of an embodiment of an air vent of a valve element in an open position;

FIG. 12 is a schematic view of an embodiment of an air vent of a valve element in an open position;

FIG. 13 is a plot of the area of outlet vs. number of turns of valve element of FIG. 12;

FIG. 14 is a schematic view of an embodiment of an air vent of a valve element in an open position;

FIG. 15 is a plot of flow rate vs. time showing a discontinuous flow rate;

FIG. 16 is a plot of flow rate vs. time for a continuous flow rate;

FIG. 17 is a cross-sectional view of another embodiment of an air-vented liquid valve in a closed position;

FIG. 18 is a cross-sectional view of the valve of FIG. 17 in the open position;

FIG. 19 is a cross-sectional view of another embodiment of an air-vented liquid valve in a closed position;

FIG. 20 is a cross-sectional view of the valve of FIG. 19 in an open position; and

FIG. 21 is an end view of a valve element of the valve of FIG. 19.

DETAILED DESCRIPTION OF THE INVENTION

It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the

present invention and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

Referring now to FIGS. 1 to 4, a closure assembly **10** having a valve body **12** and a valve member **14** is shown. The valve body **12** has a docking member **16** an annular flange **18** and a mounting sleeve **20**. The docking member **16** is for connecting the assembly **10** to a container **22** (FIG. 5). The annular flange **18** defines a first fluid conduit **24** and a second air conduit **26** extending parallel to one another. The mounting sleeve **20** defines a fluid channel **28** having an axis **30**. The fluid channel **28** is dimensioned to coaxially receive the valve member **14**. As will be described in greater detail herein, the valve member **14** is moveable from a closed position to an open position to allow liquid to flow outward from the container through the first fluid conduit **24** while air flows into the container through the second air conduit **26** without having to pass through a static or flowing liquid in the conduit.

The valve body **12** is preferably made from a polymeric material and is manufactured by a polymer processing technique. In a preferred form, the valve body is manufactured by injection molding. The first fluid conduit **24** and the second air conduit **26** are separated by a wall **32**. The wall **32** divides an internal pathway of the annular flange **18** into conduits. The first liquid conduit **24** and the second air conduit **26** are shown having differing volumes yet the invention contemplates having the first conduit and second conduit having the same or approximately the same volume. In a preferred form of the invention, the volume of the first fluid conduit **24** has a ratio with respect to the second air conduit **26** of from about 0.3 - 4.0 and more preferably from 0.5 - 3.0. The

first conduit **24** has a fluid inlet end **40** and a fluid outlet **42.** The second conduit **26** has a first air inlet **44** and a first air outlet **46**.

The mounting sleeve **20** has a generally cylindrically shaped wall having a first end **50,** a second end **52** and an outer surface **54**. A pair of circumferentially spaced, spiral extending grooves **56** extend from an intermediate portion of the mounting sleeve to proximate the first end **50**. The grooves **56** are shown extending through the entire thickness of the sleeve **20**. However, it is contemplated that grooves **56** can be provided on an interior surface of the sleeve **20** that do not extend through the entire thickness of the sidewall (less than 98% of the thickness) so that the grooves are hidden from view. The groove has a top edge **58** and a bottom edge **60** and top stop **62** and a bottom stop **64**. A protuberance **66** extends from the top edge **60** proximate the bottom stop **64**. A gap **68** separates the protuberance **66** from the bottom stop **64**. The second end **52** of the sleeve **20** has a spout **69** having a taper **70** defining a reduced diameter portion when compared to the diameter of the remainder of the sleeve **20**.

The valve element **14** has a first end **80** and a second end **82**. The valve element **14** has a generally cylindrically shaped side wall having an outer surface, a gripping projection **86** at the first end **80** and a pair of circumferentially spaced pins **88**. The pins **88** fit within the grooves **56** of the valve body. Rotation of the valve element **14** about the axis **30** causes reciprocating movement of the valve element **14** along the axis **30**. A second air outlet **94** is formed in the side wall proximate the second end **82**. When in the open position the second air outlet **94** is in alignment with the air conduit **26,** but not in alignment when in the closed position. FIG. 6 shows the valve element **14** in the closed position and FIG. 7 shows valve element **14** in an open position. The protuberance **66**

holds the valve element in the closed position to prevent inadvertent dispensing of liquid from the container. A force that can be generated by hand is sufficient to overcome the resistance of the protuberance to rotation of the valve element **14**.

In a preferred form of the invention the ratio of volumes of the second air outlet **94** and the opening of the air conduit **26** and the configuration of the second air outlet **94** and the first air inlet **44** are selected to minimize the vacuum drawn on the container contents when activating flow of fluid through the spout. It is also desirable to provide a continuous flow during dispensing to minimize or eliminate interrupted flow from the container causing a familiar "glug" sound. In another preferred form of the invention, a water-filled 1 1/2 gallon rigid container can be continuously dispensed (See FIGS. 17, 18) without interruption until the container is drained.

The valve element **14** has a second air inlet **92** on an end opposite the second air outlet **94**, a third conduit **95** defined as running through the valve element **14** from the second air inlet **92** to the second air outlet **94**. It is contemplated positioning the inlet **92** on the side wall proximate the first end **50** so that the inlet **92** is covered by the mounting sleeve when the element is in the closed position and is uncovered when moved into the open position. The inlet **92** is open to ambient air. It is contemplated closing the inlet **92** with a valve, such as a flapper valve, which would open when the valve element is in the open position.

FIG. 5 shows the assembly **10** mounted to a container **22**. The container can be made from polymeric materials, paperboard, or metal. In a preferred form, the container is a polymeric material shaped into a container by any suitable polymer processing techniques such as injection molding, blow molding, by sealing sheets of material

together to define a container or other suitable process. Suitable polymers include, but are not limited to, homopolymers and copolymers of polyolefins, polyamides, polyesters or other suitable material. One particularly suitable material is a homopolymer of ethylene and more preferably one having a density of greater than about 0.915 g/cc. In another embodiment, the material is an HDPE. In a preferred container, the sidewalls will have a modulus of elasticity of greater than 20,000 psi. In another preferred form of the container, the sidewalls of the container will not substantially collapse upon draining the contents of the container.

The configuration of the second air outlet **94** and the first air inlet **44** can take on many forms as shown in representative embodiments shown in FIGS. 8 - 12 and 14. The shape and size of the first air inlet **44** and/or second air outlet **94** can take on numerous forms including circular, semi-circular, oval, polygonal, irregular or amorphous. The first air inlet 44 can also be divided into separate chambers by a dividing wall extending between or within the internal surfaces of the first air inlet 44. It is also contemplated the first air inlet **44** may terminate with a wall having a singular outlet having one of the many shapes set forth above or have a series of sub-outlets of any shape or combination of shapes.

For the sake of brevity, FIGS. 8 - 12, and 14 are shown with the first air inlet **44** that is semicircular in shape with the valve element **14** in the full open position. It should be understood the semi-circular shape of the first air inlet **44** can be replaced by any one of the shapes or configurations described above. FIG. 8 shows the second air outlet **94** having three circular shaped sub-outlets each of approximately equal area form a triangular shape, and particularly an equilateral triangle. Thus, the sub-outlets can be

positioned to form a pattern that is circular, semi-circular, oval, polygonal, irregular or amorphous. When moving the valve element from a closed position to an open position, the first sub-outlet **104** comes into alignment with the first air inlet **44** followed by the second sub-outlet **106** and then the third sub-outlet **108.** The first sub-outlet comes into alignment with the first air inlet **44** at it is positioned higher on the valve element than the other sub-outlets. The second sub-outlet is on a leading edge **110** of the valve element, and, therefore a leading edge portion **107** of the sub-outlet **106** initially comes into alignment with the first air inlet **44** and then is joined by the third sub-outlet positioned on a trailing edge **112** of the valve element.

FIG. 9 shows a similar configuration of sub-outlets as FIG. 8 with the exception that the first sub-outlet **104** has a greater area than the second and third sub-outlets **106,108**.

FIGS, 10 and 11 show a valve element having two-sub-outlets **104** and **106.** FIG. 10 shows the first sub-outlet **104** positioned above the second sub-outlet. The distance between the first sub-inlet and the second sub-inlet can be traversed upon rotation of the valve element by a number of turns about the axis of from about $1/8^{th}$ of a turn to 1 full turn. FIG. 11 shows the first sub-outlet **104** positioned a distance ahead of the second sub-outlet **106** and this distance should be traversed by a number of turns about the axis of from about $1/8^{th}$ of a turn to 1 full turn.

FIG. 12 shows a valve element having three sub-outlets having the second sub-outlet **106** spaced a distance hl and w1 from the first outlet and the third sub-outlet **108** spaced a distance h2 and w2 from the first sub-outlet **104.** Thus the three sub-outlets form a line having a slope h2/w2.

FIG. 13 shows a graph of the area of alignment between the air outlet **94** versus the number of turns of the valve element **14** for the embodiment shown in FIG. 12. Initially the valve element is rotated for a lead in section where there is no alignment between the outlet **94** and the first inlet **44**. As the first sub-outlet **104** comes into alignment with the inlet **44** there is an initial increase in the alignment volume at an increasing rate up to the point where half the first circular sub-outlet **104** has been reached **132**, to form a first inflection point, and continues to increase at a declining rate **134** until the first sub-outlet **104** is in alignment with the inlet **44**. The inflection point **134** is reached when the valve element has traveled a distance corresponding to hl in FIG. 12**.** The area does not change **136** and the curve flattens until the second circular sub-outlet begins to come into alignment with the air inlet **44** and increases similarly at **138** as with the first sub-outlet. The third sub-outlet then comes into alignment and also increases the area in a similar fashion **140** as the first and second sub-outlets. By having the sub-outlets positioned on the valve element in these orientations allows for a sequential and discontinuous (interrupted by periods where rotation of the valve element does not increase the area of alignment) increase in the volume of the area of the sub-outlets that are in alignment with the air inlet **44**.

FIG. 14 shows a valve element with a single air outlet **94** having a triangular shape. The relatively narrow top **120** versus the wider bottom **122** allows for a continuous increase in area of alignment at an ever increasing rate **170** until the triangle is in full alignment and a maximum area is reached **172** and no increases **174** thereafter (FIG. 16).

FIG. 15 is a plot of flow rate over time for a rigid container where the flow rate increases **160** up to a rate **162** and then quickly returns to zero **164** or substantially slows **20** followed by a rapid increase **166** to a second maximum **168** and so on. This is the interrupted flow rate that occurs when a container is not properly vented and is accompanied by a "glug" sound.

FIG. 16 shows a desired flow rate over time where the flow steadily increases **170** and levels off at a maximum flow rate **172** that remains relatively constant **174.**

To use the container **22** and closure assembly **10** of FIG. 5, one starts with the container **22** having a fluid content with the valve element **14** in the closed position (FIG. 6) so that no fluid can flow from the container. The second end of the valve element **82** blocks the fluid outlet **24**. Upon rotation of the valve element **14** about the axis **30,** the pins **88** rotate within the grooves **56** past the protuberance until the pins reach the stop **62.** In this position, the second air outlet **94** is in alignment with the first air inlet **44**. Also, in the open position, a gap **93** (FIG.7) exists between the second end **82** of the valve element and the fluid outlet **42**. Fluid from the container is free to flow through the fluid inlet **40**, through conduit **24,** through the fluid outlet **42**, through the gap **93**, through the second end of the valve body and finally through the spout **69**.

FIG. 17 shows another embodiment of the closure **10**. The majority of parts are the same and therefore like reference numerals will be used for like parts. The primary difference is the valve element **14** has a valve stem **200**, a septum **202** and a push button **204**. The valve stem **200** extends through an annular guide **206** and is connected to the push button by an elongate boss **208** depending from a bottom surface of the push button. The annular guide **206** has a plurality of openings therein to allow fluid to flow through

the guide. The boss **208** forms an interference fit with the valve stem. It is contemplated adding a second or more than two annular guides **206**.

The push button is formed from an elastomeric material such as ethylene vinyl acetate (EVA); ethylene α-olefin copolymers such as VLDPE, LLDPE, ULDPE, and preferably those obtained using a single-site catalyst and even more preferably a metallocene catalyst; ethylene homopolymers; synthetic rubbers; latex; ethylene propylene rubber; ethylene propylene diene monomer (EPDM) and styrene and hydrocarbon copolymers and more preferably styrene and hydrocarbon block copolymers including di-block, tri-block, star block and more preferably SEB, SEBS, SEP, SEPS, SIS and the like. The push-button material may also be fabricated from blends of these materials. In a preferred form of the invention the push button material is EVA.

The push button is attached to the first end **50** of the cylindrical body in an annular rim **210** where it forms an interference fit within the rim. In another preferred form of the invention a portion of the cylindrical side wall will be swaged over a circumferential portion of the septum to lock it in place. The push button has a slit **212** which is pressed into a closed position until the button is pressed and the slit opens to form an air inlet **214** (FIG. 18). While only a single slit **212** is shown it is contemplated using more than one slit and positioning the slit or slits in a position where a user can press the push button without covering the slit.

As shown in FIG. 17, the septum **202** is frustoconically shaped. When the valve element is in a closed position, the septum sealing engages a complementary shaped valve seat **219** at the second end **52** of the mounting sleeve. The septum is preferably fabricated from one of the polymeric materials described above and preferably has some

elastomeric properties to flex so that it can be brought into tight engagement with the valve seat to form a fluid tight seal.

FIG. 18 shows that pathway of the liquid evacuating from the closure **220** and the pathway of air **222** into the container.

FIGS. 19 and 20 are other embodiments of the present invention and like parts will be referred to like numerals. This closure is a slide type closure wherein the valve element **14** is mounted in the mounting sleeve **20.** In this embodiment there is no annular flange as in the embodiments shown in FIGS. 1 and 18. Instead, the valve element **14** defines the air conduit **26** and the liquid conduit **24** which are divided by the wall **32**. A portion of the valve member is removed to define the air inlet **92** and on an opposite side of the valve member another portion is removed to form the liquid outlet **90.** A gripping flange **86** as is best seen in FIG. 21 is dimensioned for a user to grasp and slide away from the mounting sleeve to uncover both the air inlet **92** and the liquid outlet **90** to place the valve element in an open position.

While specific embodiments have been illustrated and described, numerous modifications come to mind without departing from the spirit of the invention and the scope of protection is only limited by the scope of the accompanying claims.